## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

| | | | | | |
|---|---|---|---|---|---|
| Return Period (years) | 1 | Foul Sewage (l/s/ha) | 0.000 | Maximum Backdrop Height (m) | 1.500 |
| M5-60 (mm) | 19.800 | Volumetric Runoff Coeff. | 0.750 | Min Design Depth for Optimisation (m) | 1.200 |
| Ratio R | 0.350 | PIMP (%) | 100 | Min Vel for Auto Design only (m/s) | 1.00 |
| Maximum Rainfall (mm/hr) | 100 | Add Flow / Climate Change (%) | 0 | Min Slope for Optimisation (1:X) | 500 |
| Maximum Time of Concentration (mins) | 30 | Minimum Backdrop Height (m) | 0.200 | | |

Designed with Level Inverts

### Time Area Diagram for Storm

| Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|
| 0-4 | 0.071 | 4-8 | 0.033 |

Total Area Contributing (ha) = 0.104

Total Pipe Volume (m³) = 4.149

### Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S1.000 | 31.970 | 0.131 | 244.0 | 0.065 | 5.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| S1.001 | 11.240 | 0.046 | 244.3 | 0.011 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| S1.002 | 6.550 | 0.027 | 242.6 | 0.028 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| S1.003 | 2.771 | 0.060 | 46.2 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | |
| S1.004 | 32.992 | 1.064 | 31.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.000 | 48.52 | 5.53 | 99.174 | 0.065 | 0.0 | 0.0 | 0.0 | 1.00 | 70.8 | 8.5 |
| S1.001 | 47.82 | 5.72 | 99.043 | 0.076 | 0.0 | 0.0 | 0.0 | 1.00 | 70.8 | 9.8 |
| S1.002 | 47.42 | 5.83 | 98.997 | 0.104 | 0.0 | 0.0 | 0.0 | 1.01 | 71.0 | 13.4 |
| S1.003 | 47.31 | 5.86 | 98.970 | 0.104 | 0.0 | 0.0 | 0.0 | 1.48 | 26.2 | 13.4 |
| S1.004 | 46.25 | 6.16 | 98.910 | 0.104 | 0.0 | 0.0 | 0.0 | 1.81 | 32.1 | 13.4 |

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## Manhole Schedules for Storm

| MH Name | MH CL (m) | MH Depth (m) | MH Connection | MH Diam.,L*W (mm) | Pipe Out PN | Pipe Out Invert Level (m) | Pipe Out Diameter (mm) | Pipes In PN | Pipes In Invert Level (m) | Pipes In Diameter (mm) | Backdrop (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S1 | 100.135 | 0.961 | Open Manhole | 1200 | S1.000 | 99.174 | 300 | | | | |
| S2 | 100.420 | 1.377 | Open Manhole | 1200 | S1.001 | 99.043 | 300 | S1.000 | 99.043 | 300 | |
| S3 | 100.282 | 1.285 | Open Manhole | 1200 | S1.002 | 98.997 | 300 | S1.001 | 98.997 | 300 | |
| S4 | 100.150 | 1.180 | Open Manhole | 1200 | S1.003 | 98.970 | 150 | S1.002 | 98.970 | 300 | |
| S5 | 100.110 | 1.200 | Open Manhole | 1200 | S1.004 | 98.910 | 150 | S1.003 | 98.910 | 150 | |
| SHWALL | 98.400 | 0.554 | Open Manhole | 0 | | OUTFALL | | S1.004 | 97.846 | 150 | |

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## Area Summary for Storm

| Pipe Number | PIMP Type | PIMP Name | PIMP (%) | Gross Area (ha) | Imp. Area (ha) | Pipe Total (ha) |
|---|---|---|---|---|---|---|
| 1.000 | - | - | 100 | 0.065 | 0.065 | 0.065 |
| 1.001 | - | - | 100 | 0.011 | 0.011 | 0.011 |
| 1.002 | - | - | 100 | 0.028 | 0.028 | 0.028 |
| 1.003 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.004 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| | | | | Total | Total | Total |
| | | | | 0.104 | 0.104 | 0.104 |

## Free Flowing Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| S1.004 | SHWALL | 98.400 | 97.846 | 0.000 | 0 | 0 |

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## Online Controls for Storm

### Hydro-Brake® Optimum Manhole: S4, DS/PN: S1.003, Volume (m³): 1.7

| | | | |
|---|---|---|---|
| Unit Reference | MD-SHE-0101-5000-1300-5000 | Sump Available | Yes |
| Design Head (m) | 1.300 | Diameter (mm) | 101 |
| Design Flow (l/s) | 5.0 | Invert Level (m) | 98.970 |
| Flush-Flo™ | Calculated | Minimum Outlet Pipe Diameter (mm) | 150 |
| Objective | Minimise upstream storage | Suggested Manhole Diameter (mm) | 1200 |
| Application | Surface | | |

| Control Points | Head (m) | Flow (l/s) | Control Points | Head (m) | Flow (l/s) |
|---|---|---|---|---|---|
| Design Point (Calculated) | 1.300 | 5.0 | Kick-Flo® | 0.798 | 4.0 |
| Flush-Flo™ | 0.384 | 5.0 | Mean Flow over Head Range | - | 4.4 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.100 | 3.4 | 0.600 | 4.8 | 1.600 | 5.5 | 2.600 | 6.9 | 5.000 | 9.4 | 7.500 | 11.4 |
| 0.200 | 4.7 | 0.800 | 4.0 | 1.800 | 5.8 | 3.000 | 7.4 | 5.500 | 9.8 | 8.000 | 11.8 |
| 0.300 | 4.9 | 1.000 | 4.4 | 2.000 | 6.1 | 3.500 | 7.9 | 6.000 | 10.3 | 8.500 | 12.1 |
| 0.400 | 5.0 | 1.200 | 4.8 | 2.200 | 6.4 | 4.000 | 8.5 | 6.500 | 10.7 | 9.000 | 12.5 |
| 0.500 | 4.9 | 1.400 | 5.2 | 2.400 | 6.7 | 4.500 | 9.0 | 7.000 | 11.0 | 9.500 | 12.8 |

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## Storage Structures for Storm

### Cellular Storage Manhole: S2, DS/PN: S1.001

Invert Level (m) 99.058 Infiltration Coefficient Side (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Base (m/hr) 0.00000 Safety Factor 2.0

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|---|---|---|
| 0.000 | 26.0 | 26.0 | 1.200 | 26.0 | 51.2 | 1.300 | 0.0 | 51.2 |

### Tank or Pond Manhole: S4, DS/PN: S1.003

Invert Level (m) 98.970

| Depth (m) | Area (m²) |
|---|---|
| 0.000 | 19.0 |

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## Summary of Critical Results by Maximum Level (Rank 1) for Storm

### Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 40.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 2 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.800 Cv (Summer) 0.750
Region England and Wales Ratio R 0.350 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DTS Status ON Inertia Status OFF
Analysis Timestep Fine DVD Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period (years) 100

| PN | US/MH Name | Storm | Return Period | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Pipe Flow (l/s) | Status | Level Exceeded |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 60 Winter | 100 | 100/30 Summer | | | | 99.673 | 0.199 | 0.000 | 0.30 | | 19.2 | SURCHARGED | |
| S1.001 | S2 | 60 Winter | 100 | 100/15 Summer | | | | 99.669 | 0.326 | 0.000 | 0.13 | | 7.6 | SURCHARGED | |
| S1.002 | S3 | 60 Winter | 100 | 100/15 Summer | | | | 99.666 | 0.369 | 0.000 | 0.30 | | 15.3 | SURCHARGED | |
| S1.003 | S4 | 60 Winter | 100 | 100/15 Summer | | | | 99.664 | 0.544 | 0.000 | 0.33 | | 5.0 | SURCHARGED | |
| S1.004 | S5 | 60 Winter | 100 | | | | | 98.950 | -0.110 | 0.000 | 0.16 | | 5.0 | OK | |

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